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Chapter 4 - Sensation and Perception

Introduction to Psychology (York University)

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Chapter 4: Sensation and Perception

- **Synesthesia** is a condition where sensory experience in one domain is accompanied by a sensory experience in another domain.

- **Sensation** is the stimulation of sense organs.
- **Perception** is the selection, organization, and interpretation of sensory input.
    - Perception involves organizing and translating sensory input into something meaningful, such as a face.

Psychophysics: Basic Concepts and Issues

- **Psychophysics:** The study of how physical stimuli are translated into psychological experience.
- Gustav Fechner → an important contributor to psychophysics.

Thresholds: Looking for Limits

- **Threshold:** A dividing point between energy levels that do and do not have a detectable effect.
    - For example, a lamp that automatically turns on when a room gets dark. The level of light intensity at which the lamp turns on is its threshold.
- The **absolute threshold** for a specific type of sensory input is the minimum amount of stimulation that an organism can detect at which the probability of detection is **50%**.

- Fechner was also interested in people's sensitivity to differences between stimuli and the concept of the threshold.
- A **just noticeable difference (JND)** is the smallest difference in the amount of stimulation that a specific sense can detect.
- In fact, an absolute threshold is simply the JND from nothing (no stimulation input).
- The principle of JND was first demonstrated by Weber.
- **Weber's law:** The theory stating that the size of a just noticeable difference is a constant proportion of the size of the initial stimulus. The constant proportion is called the Weber fraction.

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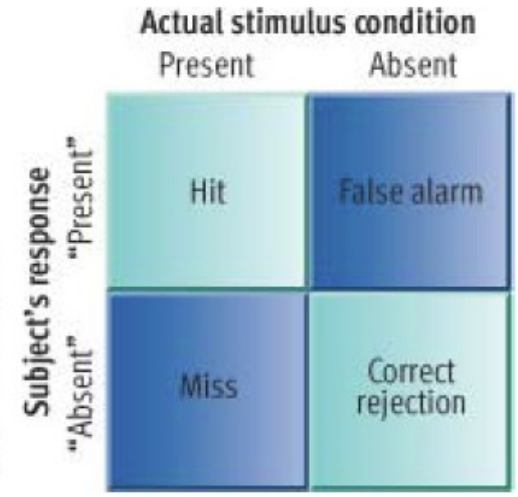
- For example, the Weber fraction for lifting weights is about 1/30. This means that you should just be able to detect the difference between a 300 gram weight and a 310 gram weight (i.e. the JND for 300 grams is 10 grams).

Signal-Detection Theory

- **Signal-detection theory:** A theory proposing that the detection of stimuli involves decision processes as well as sensory processes, which are influenced by a variety of factors besides the physical intensity of a stimulus.

- There are four possible outcomes that are possible in attempting to detect the presence of weak signals:



Perception and Awareness

- Can sensory information that fall beneath the threshold of awareness still influence behaviour? This issue centres on the concept of subliminal perception.
- **Subliminal perception:** The registration of sensory information without conscious awareness. (hidden messages influencing behaviour)

Sensory Adaptation

- **Sensory adaptation**: A gradual decline in sensitivity to prolonged stimulation.
- Sensory adaptation keeps people tuned in to the changes rather than the constants in their sensory input.

Sensory Receptors

- Detect environment stimuli.
- Convert stimulus energy into electrochemical signals.

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Our Sense of Sight: The Visual System

The Eye: A Living Optical Instrument

* Basic components of the eye covered in NATS 1870.
- Light varies in terms of wavelength, amplitude, and purity.
- Perceptions of colour (hue) are primarily a function of light wavelength, while amplitude affects brightness and purity affects saturation.
- The retina transforms light into neural impulses that are sent to the brain via the optic nerve.
- Cornea is where the light enters the eye; the pupil regulates the amount of light, and the lens focuses the light rays on the retina. Accommodation occurs when the curvature of the lens adjusts to alter visual focus.
- **Saccades:** Eye movements made when your eyes are scanning the visual environment and making brief fixations at various parts of the stimuli.
    - If there were none of these eye movements, if you were able to stop these movements while looking at your sleeping dog, for example, your visual system would adapt, and your dog would simply fade from view due to *sensory adaptation*.

The Retina: The Brain's Envoy in the Eye

- **Retina:** The neural tissue inside the back surface of the eye that absorbs light, processes images, and sends visual information to the brain.
- The cells closest to the back of the eye – rods and cones – are the receptor cells that actually detect light.
- The axons that run from the retina to the brain converge at the **optic disk** – a hole in the retina where the optic nerve fibres exit the eye. There are no rods or cones in this point of the retina (blind spot). Each eye normally compensates for the blind spot of the other eye.

- **Dark adaptation**: The process in which the eyes become **more sensitive** to light in low illumination.
    - When you come from outside and enter a dark room, at first you can't see anything but within minutes, you can make your way around quite well as your eyes adapt to the darkness.
    - In the image below, the declining thresholds over time indicate that your visual sensitivity is improving, as less and less light is required to see with time.

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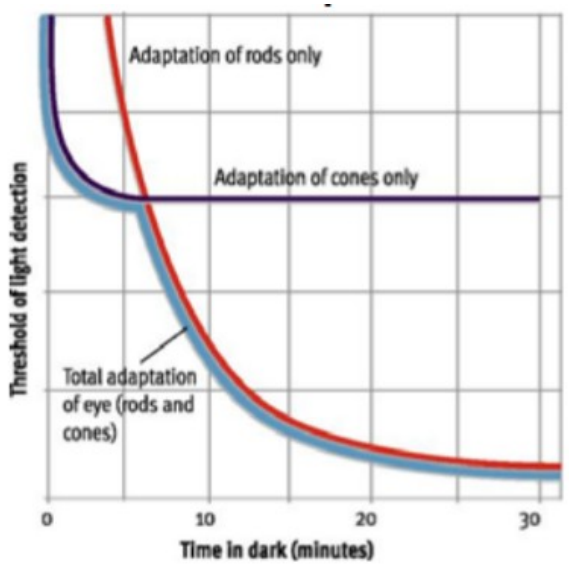

- **Light adaptation:** The process whereby the eyes become **less sensitive** to light in high illuminations.

- The opposite of dark adaptation. Now, assume you emerge from dark room and go outside on a sunny day, you will be overwhelmed with brightness before the eyes adjust!

- Light striking the retina's receptors (rods and cones) triggers neural signals which ultimately send impulses along the optic nerve. These axons, which depart from the eye through the optic disk, carry visual importation, encoded as a stream of neural impulses, to the brain.
- The collection of rod and cone receptors that funnel signals to a particular visual cell in the retina (or ultimately the brain) make up that cell's **receptive field**.
- The rate of firing of a visual cell might be increased by light in the centre of its receptive field and decreased by light in the surrounding area.

- **Receptive field** is the retinal area that, when stimulated, affects the firing of that cell.

Vision and the Brain

- Axons leaving the back of each eye form the optic nerves, which travel to the **optic chiasm** – the point at which the optic nerves from the inside half of each eye cross over and then project to the opposite half of the brain.
- Most visual input eventually arrives in the primary visual cortex, located in the occipital lobe.

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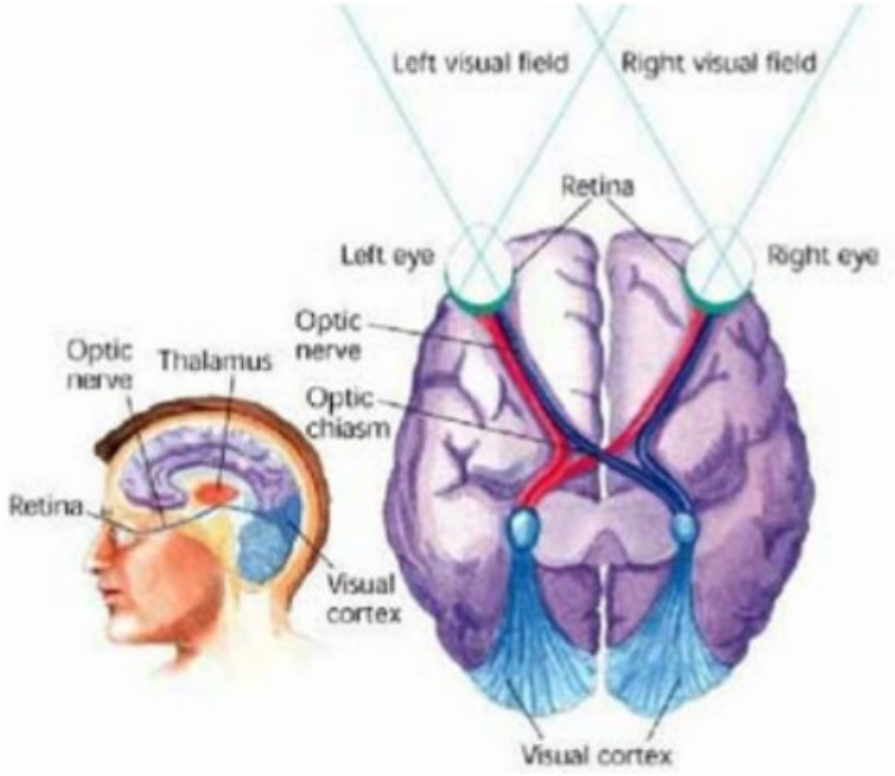

- Input from the right half of the visual field strikes the left side of each retina and is transmitted to the left hemisphere.
- Input from the left half of the visual field strikes the right side of each retina and is transmitted to the right hemisphere.
- The nerve fibres from each eye meet at the optic chiasm, where fibres from the inside half of each retina cross over to the opposite side of the brain.

Information Processing in the Visual Cortex:

- Most visual input eventually arrives in the primary visual cortex, located in the occipital lobe.
- Individual cells in the primary visual cortex don't really respond much to little spots – they are much more sensitive to lines, edges, and other more complicated stimuli.
- Hubel and Wiesel found that various types of specialized cells in the primary visual cortex respond to different stimuli.
- **Feature detectors:** Neurons that respond selectively to very specific features of more complex stimuli such as lines, edges, etc.
- This explains why some people are unable to recognize familiar faces (**prosopagnosia**); those cells responsible may be damaged.
- Inability to recognize common objects is known as **agnosia**.

Viewing the World in Colour

- Colour is determined by the wavelength of the light the object reflects, not based on the inherent nature of the object.

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- Two kinds of colour mixtures: subtractive and additive.

Trichromatic Theory of Colour Vision (lead by Thomas Young):

- The **trichromatic theory** of colour vision holds that the human eye has three types of receptors with differing sensitivities to different light wavelengths (RGB).
  - We see all colour as a mixture of these three colours.
  - Three types of cones.

Opponent Process Theory of Colour Vision (Lead by Hering):

- The **opponent process theory** of colour vision holds that colour perception depends on receptors that make antagonistic responses to three pairs of colours (Red vs. green, blue vs. yellow, black vs. White)
  - **Complementary colours**: Pairs of colours that produce grey tones when mixed together.
  - The colour of the after-image you see is the complementary colour of the original colour (the trichromatic theory alone fails to explain this concept).

- Our current view of colour vision is that it is based on both theories.

The Visual System: Perceptual Processes

- **Reversible figure:** A drawing that is compatible with two different interpretations that can shift back and forth.
- **Perceptual Set:** A readiness to perceive a stimulus in a particular way. Can influence which image in the reversible figure you see first.

Bottom-up vs. Top-down processing:

- Bottom-up processing progresses from individual elements into whole elements, whereas top-down processing progresses from the whole to the individual elements.
- For example, when reading a sentence, we perceive the words before its individual letters (top-down processing).
- **Gestalt psychology** (a school of thought) demonstrated that the whole can be greater than the sum of its parts.

Gestalt Principles of Perceptual Organization (integrating, organizating, and interpreting sensory information):

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- Proximity: Elements that are close together tend to be groups together (dots example – vertical or horizontal pattern?)
- Closure: Filling in the blanks of incomplete figures.
- Similarity: Can be similarity of colour.
- Simplicity: We are more likely to view images in the simplest way possible.
- Continuity: We tend to see elements in ways that produce smooth continuation.

- Gestalt psychologists also though that an important part of our perception was the organization of a scene into its *figure* and *background*.

Formulating Perceptual Hypothesis:

- Two kinds of stimuli: distal and proximal
- **Distal stimuli** are stimuli that lie in the distance (in the world outside our body). These are simply the objects we look at. Our eyes don't touch distal stimuli. What our eyes do "touch" are the images formed by light falling on our retinas. These images are the **proximal stimuli** – the stimulus energies that impinge directly on sensory receptors.
- There are great differences in the objects you perceive and the stimulus energies that represent them.
- In vision perception, the proximal stimuli are distorted, two-dimensional versions of their actual, three-dimensional counterparts.
- Consider the distal stimuli of a square. As you move away from the paper square such as in (b) and (c), it is actually projecting a trapezoid (the proximal stimulus) onto your retinas.

- **Perceptual hypothesis:** An inference about which distal stimuli could be responsible for the proximal stimuli sensed.

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- This bridges the gap between distal and proximal stimuli by constantly making and testing hypothesis about what's out there in the real world. This is why we continue to perceive a square even as we move away because our perceptual system "guesses" correctly that it's a square.

Perceiving Depth or Distance

- **Depth perception** involves interpretation of visual cues that indicate how near or far away objects are. How we see the 3D world using 2D retinal images.
- To make judgements of distance there are two types of clues:

Binocular depth cues: Clues about the distance based on the differing views of the two eyes.

- Two types: Retinal disparity and convergence

Monocular depth cues: Clues about distance based on the image from either eye alone.

- Two types: Motional parallax and pictorial depth cues.
- 6 pictorial depth clues: linear perspective, texture gradients, interposition, relative size, height in plane, light and shadow.

Perceptual Constancies in Vision

- **Perceptual constancy:** A tendency to experience a stable perception in the face of continually changing sensory input.
    - For example, a person approaching you from a distance. We don't perceive them as changing size; instead, we perceive them as getting closer or further.

The Power of Misleading Cues: Optical Illusions

- **Optical illusions** demonstrate that perceptual hypotheses can be inaccurate and that perceptions are not simple reflections of objective reality.
- For example: The Ames Room

Our Sense of Hearing: The Auditory System

The Stimulus: Sound

- Sound waves are vibrations of molecules, which means that they must travel through some physical medium, such as air.

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Physical properties of sound	Related perceptions
Amplitude	Loudness
Frequency	Pitch
Purity	Timbre

→ measured in decibels

→ measured in hertz

- Amplitude is the principle determinant of loudness, but loudness ultimately depends on an interaction between amplitude and frequency.
- Auditory signals are transmitted through the thalamus to the auditory cortex in the temporal lobe.

Sensory Processing in the Ear

- The human ear can be divided into three sections.
  - The external ear → depends on the vibration on air molecules
  - The middle ear → depends on the vibration of movable bones
  - The inner ear → depends on waves in a fluid. The inner ear consists largely of the **cochlea** – a fluid that contains the receptors for hearing. The **basilar membrane** inside the cochlea holds the auditory receptors called **hair cells**.

Auditory Perception: Theories of Hearing

- **Place Theory** (Helmhotz): The idea that perception of pitch corresponds to the vibration of different portions, or places, along the basilar membrane.
  - Specific sound frequencies vibrate specific portions of the basilar membrane, producing distinct pitches.
  - The brain detects the frequency of a tone according to which area along the basilar membrane is most active.

- **Frequency Theory** (Rutherford): Perception of pitch corresponds to the rate, or frequency, at which the entire basilar membrane vibrates.

- The structure of the ear transform changes in air pressure (sound waves) into vibrations of the basilar membrane. As it vibrates, it causes the hair in the hair cells to bend to which leads to a change in the electrical potential within the cell; this is carried through the auditory nerve to the thalamus and auditory cortex.

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Featured Study of the chapter → Musical training enhanced participants' ability to decode emotions conveyed by speech prosody.

Chemical Senses: Taste and Smell

The Gustatory System (Sensory System for Taste)

- The receptors found in taste buds are **gustatory cells**.
- Our taste buds are sensitive to four basic tastes: sweet, sour, bitter, and salty.
- Sensitivity to these tastes is distributed unevenly across our tongue, but the variations are small.
- Taste preferences are largely learned and can be heavily influenced by one's cultural background.
- The perception of flavour is influenced greatly by the odour of food and other non-consumable factors.

The Olfactory System (Sensory System for Smell)

- The receptors for smell are **olfactory**.
- Smell is the only sensory system in which the incoming information in not routed through the thalamus before it projects to the cortex.
- **Pheromones** are chemical messages that can be sent by on organism and received by another member of the same species.

Our Sense of Touch: Sensory System in the Skin

- Sensory receptors in the skin respond to pressure, temperature, and pain.
- The human skin has at least 6 types of sensory receptors. Different receptors are responsible for different sensory feels such as pain, temperature, etc.
- Temperature → receptors reactive to cold/warm.
- Pain signals are sent to the brain along two pathways that are characterized as fast and slow.
    - Fast pathway – the initial sharp pain
    - Slow pathway – the pain you feel after; lags behind the fast system.
- Pain signals may be sent to many areas in the cortex.
- The perception of pain can be influenced greatly by expectations, personality, mood, and other factors involving higher mental processes.
- Many people report relief from pain when given a placebo.

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- The central nervous system can actually block incoming pain signals when you get distracted from your pain source.
- **Gate-control theory:** The idea that incoming pain sensations must pass through a "gate" in the spinal cord that can be closed, thus blocking pain signals.
- Endorphins (our bodies own "painkillers") play an important role in the modulation of pain by the central nervous system.

Our Other Senses

The Kinesthetic System

- **Kinesthetic system:** The sensory system that monitors the positions of the various parts of one's body in relation to each other.
    - **Proprioceptors:** Receptors in muscles and joints that provide information about body position and movement.

The Vestibular System

- **Vestibular System:** The sensory system that responds to gravity and keeps people informed of their body's location in space.
- Provides our sense of balance, or equilibrium, compensating for the changes in the body's position.

- **Door-in-the-face technique**: Making a large request first that is likely to be turned down as a way to increase the chances that people will agree to a smaller request later.

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